

BIOLOGY & CONSERVATION

OF SEA TURTLES

IN THE INDIAN OCEAN

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Read from to 2309

(63)

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INTRODUCTION

The Indian Ocean, with its contiguous seas and gulfs, is mankind's oldest ocean; and has been intimately related with his history and development. Ancient civilizations arose along its shores and traded across its waters. Yet, this great ocean, one-seventh of the earth's surface (Figure 1), has been forgotten in the last Century, and despite man's long attendance, the Indian Ocean is one of the most poorly known of the great seas. This lack of knowledge extends throughout the general realm of marine biology, including marine turtles.

That some of the world's largest nesting populations have been found in the Indian Ocean in the last decade is evidence of our ignorance: Chelonia mydas nests in the thousands on Europa Island, Comores, Southern Yemen, Oman and Pakistan (Hughes, 1971; Servan, 1976; Frazier, 1972, 1975a; FAO, 1968, 1973; Ross, pers. comm., 1979; Zaidi and Ghalib in Salm, 1975a). Eretmochelys imbricata may have some of its most concentrated nesting areas in the world in the Suakin Archipelago and Persian Gulf (Moore and Balzarotti, 1977; Walczak and Kinunen, 1971). The largest known rookery of Caretta caretta is on Masirah Island (FAO, 1973; Anon., 1978). Tens or hundreds of thousands of Lepidochelys olivacea evidently nest in Pakistan and east India (Singh, in lit., 20 July 1976; Davis, 1977; Davis and Bedi, 1978).

Despite this great lack of knowledge, two of the earliest studies of marine turtles, which still stand as invaluable benchmarks, were conducted in the Indian Ocean: Hornell (1927) in Seychelles and Deraniyagala (1939) in Sri Lanka. After the studies of Hornell and Deraniyagala, no detailed studies were made in the region until 1963 (McAllister, et al., 1965) when research

in Natal was begun; this continues (Hughes, 1977a, 1982), and the program expanded to encompass the southwest Indian Ocean (Hughes, 1971, 1973a, 1973b, 1974a, 1974b, 1982).

Other short term projects, funded by FAO (1968, 1973) made valuable contributions in southern Arabia. Studies in Seychelles, BIOT, Comores and East Africa extended from 1968 to 1976 (Frazier, 1971, 1972, 1975a, 1977, in press; Gibson, 1979). During this time attempts were made to collate information on the western Indian Ocean Region and to stimulate preliminary studies, distributing questionnaires and preliminary synopses to hundreds of addressees (Frazier, 1974, 1975b). Subsequently, studies have been conducted in Sudan (Moore and Balzarotti, 1977); Siani (Sella, *in lit.*, Jan 1976; 1982); Yemen Arab Republic (Walczak, 1975; 1979); and India (Bhaskar, 1978a-f; 1979a-d; Kar and Bhaskar, 1982), and a long term study continues on Cousin Island, Seychelles (Diamond, 1976; Garnett, 1979; Frazier, in press). A joint IUCN/Oman Government study has been initiated on Masirah Island and Oman (Anon., 1978; Ross and Barwani, 1982), and preliminary marine park surveys were done in Sri Lanka, India and Pakistan (Salm, 1975a, 1975b, 1976b).

Much remains to be surveyed, but of the 31 territories in the western Indian Ocean, 19 have had recent surveys. The most recent compendium of information on the Indian Ocean is in the proceedings of the World Conference on Sea Turtles, held in 1979 (Frazier, 1982a; 1982b; Hughes, 1982; Kar and Bhaskar, 1982; Ross and Barwani, 1982; Sella, 1982).

The present paper will summarize the situation over the entire western Indian Ocean; the eastern Indian Ocean, from the east coast of India eastward, will not be treated. Details for each territory are given in the references at the end of each summary.

Five species of marine turtles occur in the Indian Ocean: Dermochelys coriacea (L.); Chelonia mydas (L.); Eretmochelys imbricata (L.); Caretta caretta (L.); and Lepidochelys olivacea (Eschscholtz). Subspecies for all of these turtles have been named, but there is little evidence that any subspecific populations are identifiable except on geographic grounds (see Frazier, in press a). A discussion of exploitation in each of the territories discussed here has been presented (Frazier, 1980; 1982).

ACCOUNT BY COUNTRIES

Southwest Indian Ocean (see Hughes, 1982):

South Africa. Thoroughly studied by Hughes and colleagues, the program is 15 years old. Concentrated nesting of Caretta and Dermochelys occurs in the reserve in northern Natal. Their numbers have evidently increased in response to continued and efficient protection. Now, over 400 Caretta and some 70 Dermochelys nest each year. Chelonia, and less frequently Eretmochelys and Lepidochelys, occur as vagrants farther south. The latter nests very rarely (Hughes, 1974a, 1974b, 1977a).

Mozambique. All five species occur and breed. Caretta and Dermochelys nest on mainland beaches in the southern half; annual numbers are perhaps 300 and less than 50 respectively. Tag returns from Tongaland indicate that Mozambique is an important feeding ground for the nesting population in Natal. Lepidochelys evidently nests sporadically along the mainland in the northern half. Perhaps 500 to 1,000 nest in a year. Chelonia is the most common species frequenting marine pastures along the mainland. An estimated 200 nest annually on the Primeiras and Segundas Islands. Nesting also occurs in the north on the other islands and the mainland, but there are few.

Eretmochelys is also more common in the north. It seems nesting is mainly on islands but may also occur on the mainland. There are not likely to be more than 100 nesting in a year. The Caretta and Dermochelys populations are doomed if intense exploitation on nesting females and nests continues (Hughes, 1973a, 1976).

Madagascar. There are fair-sized populations of all turtles but Dermochelys. Lepidochelys does not nest but there is a large feeding population in the north-west. Caretta nests in the south and especially in the southeast; there may be 300 nesting in a year (Hughes, 1974a). Eretmochelys nest along the north and west, apparently preferring islands, but there is reputed to be concentrated nesting in the northeast (Hughes, 1973b). The number nesting may be substantial, but there are no details. Chelonia are common on all coasts. Large numbers of subadults and also tag returns from Europa and Tromelin Islands indicate that this is an important feeding area for several populations. There is a small amount of nesting along the west coast and on offshore islands. An estimated 300 nest annually on Chesterfield (Hughes, 1974a, 1976).

Reunion. The main island has no significant turtle populations, although any but Lepidochelys might occur on occasion. The four tropical islands that are dependencies have important populations. Glorieuse has an estimated 250 Chelonia and 50 Eretmochelys nesting annually (Frazier, 1975a). Tromelin has a large Chelonia rookery, estimated to have 2,000 nesting yearly (Hughes, 1976) (although it was previously estimated to have only 200 to 400 (Hughes, 1974a) see Hughes, 1982 for other recent estimates). Europa's population is one of the largest in the western Indian Ocean region. It was first estimated to have 5,000 to 9,000 annual nesters (Hughes, 1974a), but the estimate has since been reduced to 2,000 (Servan, 1976), and then increased substantially (see Hughes, 1982). Iles Barren, or Bassas da India, were estimated to have 200 nesting in a year (Hughes, 1976).

Mauritius. Turtle populations at the large islands of Mauritius and Rodriguez are insignificant, but Chelonia and Eretmochelys may occur. Subadult Caretta evidently occur in transit during their pelagic phase, and Dermochelys are rare. The low-lying St. Brandon islands have a nesting population of Chelonia, from which about 300 are cropped annually (Hughes, 1975). The total number nesting is evidently less than 1,000; it may be only 300 (Hughes, 1976). Eretmochelys probably nest in small numbers. Eretmochelys and Chelonia may nest in small numbers on Agalega Island.

Central and Western Indian Ocean: (see Frazier, 1982a):

British Indian Ocean Territory (BIOT). This territory consists of the Chagos Archipelago, which was formerly a dependency of Mauritius. Before Seychelles' independence in 1976, BIOT included also Aldabra, Farquhar and Desroches Atolls. The 65 islands in the Archipelago offer large areas of feeding and nesting habitat to both Chelonia and Eretmochelys. However, the only nesting known involves small numbers, although little of the Archipelago has been surveyed. Chagos is not known for turtles, although there is some indication that the Islands may have once supplied large amounts of tortoise-shell to Mauritius, they seem to have been of little importance generally. Only 300 Chelonia are estimated to nest in a year, and the peak nesting season is during the southeast trades, from June to September. The maximum estimate for the number of Eretmochelys nesting annually is 300, and peak nesting is evidently during the northwest monsoon. Perhaps a few hundred of each species were captured annually. The lagoons may serve as important nursery grounds for Chelonia and there are many uninhabited islands and beaches (Frazier, 1977).

Seychelles. This island republic covers hundreds of thousands of square km of the western Indian Ocean, including half a dozen major island groups and over 50 major islands. There are extensive reefs and many remote beaches. All but Lepidochelys have been documented. Dermochelys and Caretta are rarely reported. Eretmochelys feeds and nests throughout the territory, but seems most abundant in the Granitic Islands, and at some of the coralline islands with large lagoons (eg., Cosmoledo and Providence). Nesting has been recorded in all months but June, and the peak is from October to January. The most concentrated nesting occurs on Cousin, where 30 to 40 nest a year. There are evidently less than 600 nesting annually in the whole territory. Chelonia also feeds and nests throughout the territory, but most nesting occurs in the Aldabra group of islands. Throughout the whole territory an estimated 2,500 nest in a year. Nesting is year-round with a peak during the southeast trades, from about May to September. The Seychelles are world famous for both Chelonia and Eretmochelys, but Chelonia populations have declined after heavy exploitation and Eretmochelys are under heavy pressure (Frazier, 1971, 1975a, 1979, in press a; Gibson, 1979).

Mayotte. Geographically part of the Comoro Archipelago, but politically a department of France, the island offers rich reef and lagoon habitats. Only Chelonia and Eretmochelys are recorded, and numbers seem to be smaller than the habitat could support. Estimates were 500 Chelonia and 25 Eretmochelys nesting annually. The most important rookery for Chelonia is on Pamanzi Island in the northeast. Nesting is probably year-round, peaking about June-July. The island supplies small amounts of tortoise-shell and Chelonia meat, but has never been known as an important turtle area (Frazier, 1972, 1975a, in press b).

Comores. Only Chelonia and Eretmochelys are recorded, although Dermochelys may also occur. The two larger islands of the Republic have few beaches and small neritic habitats. Neither Ngazidia (Grand Comore) nor Anjouan has nesting of significance; possibly a few dozen Chelonia nest on both islands. There may be small nursery areas, such as in the northwest of Ngazidia; and Anjouan may have rich reefs, but the areas are small and turtle populations probably number only a few hundred. Moheli, on the other hand, has many beaches and considerable shallow water with offshore islands and rich reefs. Of 89 beaches, 6 had large nesting populations of Chelonia and the total estimate for Moheli was 1,850 nesting annually. The total estimate for the Republic was 1,900. Possibly 50 Eretmochelys nest annually at Moheli.

The Comores are not noted for their turtles, and the presence of such a large nesting population of Chelonia was not expected. Dense human populations and lack of sufficient food leave the two larger islands of little value to turtles, but disturbance on Moheli seems low enough to be sustainable (Frazier, 1972, 1975a, 1977, in press b).

Tanzania. Rich reefs and marine pastures are abundant, but much of the coast is unsuitable for nesting. Off-lying islands near Mafia and Zanzibar do offer excellent, but restricted, nesting habitat. All five turtles occur. Dermochelys and Lepidochelys are rarely reported, but may be more common than is often assumed. The latter nests, but in small numbers. Caretta are seen uncommonly, but females tagged in Natal have been recaptured as far north as Zanzibar, and southern Tanzania seems to be part of the feeding range for animals that nest in Natal. Eretmochelys nests throughout the Republic. On Maziwi, the best rookery, 20 might nest annually, and perhaps a total of 50 nest yearly in the entire country. There is nesting year-round but from February to March it

peaks. Chelonia nests on Maziwi round the year, but mostly from June to October. Less than 200 nest annually. Shungu-Mbili Island also has considerable nesting, and there is some nesting on the mainland south of Dar es Salaam. Yet, the grand total nesting in a year is estimated at less than 300. Zanzibar was once a major clearing house in tortoise-shell importing and exporting from and to all parts of the world, however, Tanzania itself was not a major producer. Turtle populations are probably reduced from previous levels from persistent predation on reproducing animals and human habitations on nesting beaches (Frazier, 1975b, 1975c).

Kenya. Much of the coast is unsuitable for nesting, but there are large marine pastures and some rich reef areas. All five turtles probably occur, but Caretta has not been documented. Only Eretmochelys and Chelonia are recorded nesting, although Lepidochelys probably also nests, but in smaller numbers. Eretmochelys and Chelonia nest along much of the coast, but most nesting is in the north, especially on islands. The most Chelonia nesting occurs on the mainland around Ras Tenewi, after August. However, nest predation here is great and recruitment is probably insignificant. Probably less than 50 Eretmochelys and less than 200 Chelonia nest in a year (Frazier, 1975d).

Somalia. Thousands of kilometers of sandy beach and rich upwelling currents characterize this coast. All five species of turtle are known to Bajun fishermen in the south (Grotanelli, 1955), but only Chelonia seems to be common. It occurs along the entire eastern coast (Ninni, 1937). At least Chelonia nest (Cozzolino, 1938) and there are accounts of large nesting grounds and rich turtle areas (Travis, 1967; Travis in Goodwin, 1971), but little is documented. There might be a few thousand nesting annually on several stretches of the eastern coast. Rich marine pastures support dugongs and also Chelonia (Travis, 1967). South

Arabian turtles evidently migrate to Somalia for feeding (FAO, 1968, 1973).

Eretmochelys are exploited, but the numbers taken indicate a small population (Frazier, this volume). This is to be expected, given the cold upwelling waters off the Somali coast. Evidently other species are uncommon or rare.

Gulf of Aden and Red Sea (see Frazier, in press c; Frazier and Salas, in press; Ross and Barwani, 1982; Sella, 1982).

Djibouti. Nothing seems to be recorded, but Eretmochelys and Chelonia are likely to occur, at least in small numbers.

Ethiopia (Eretria). Off the arid coastline is the Dhalak Archipelago, and this seems to be the only important turtle area. It provides rich reef areas and numerous beaches. Last century Lepidochelys and Eretmochelys were collected (Rüppell, 1835; Steindachner, 1900), and Chelonia and Eretmochelys were collected in this century (Hoofien and Yaron, 1965). Chelonia has been reported nesting (Urban, 1970; Minot, n.d.), and Eretmochelys is also suspected to nest. The numbers of the latter may be, or have been, substantial, but there are no records. The Chelonia population is probably small, but there may be large pastures along the mainland coast. The nesting population on the Dhalak Islands may have been heavily exploited (Minot, n.d.).

Sudan. Numerous islands, including the Suakin Archipelago, lie off the arid coast. Eretmochelys is recorded from the north (Steindachner, 1900) and the Suakin Islands where they nest (Moore and Balzarotti, 1977). Chelonia have been seen along the mainland coast and a specimen of Lepidochelys was seen in a market. Chelonia may nest in large numbers on the islands. Over 300 Eretmochelys are estimated to nest annually in just the Suakin Archipelago (Moore and Balzarotti, 1977), but there are a great many more islands that may also have nesting. This represents the greatest known concentration of nesting Eretmochelys. Present-day exploitation is little, although it may have been

intense in the past.

Egypt. Islands lie off the desert coast and from them Chelonia and Eretmochelys have been recorded (Steindachner, 1900); Eretmochelys has also been recorded from the southern mainland (Marx, 1968). Both these turtles are likely to breed, but little else is recorded.

Siani (see Sella, 1982). All five species are recorded; in order of increasing abundance: Caretta, Lepidochelys, Dermochelys, Eretmochelys and Chelonia. Only Chelonia is frequently seen, and only it is known to nest. An estimated 80 per year nest at Abu-Rodes, but there is some nesting also at Ras Muhammad and on Tiran and Sanafir Islands. Exploitation is mainly incidental or accidental, through underwater bombings or catches in nets (Sella, in lit., January 1976; 1 March 1976; 20 August 1976).

Israel. There are only about 12 km of coast, in the Gulf of Eilat, and although an active marine station is at the town of Eilat, there seems to be absolutely no information available on marine turtles.

Jordan. There is only a short stretch of coast, about 12 km long in the Gulf of Eilat, and nothing seems to be recorded. Pollution by crude oil is evidently bad (Fitter, in lit., 2 October 1975).

Saudi Arabia (Red Sea coast). A long coast with large numbers of islands, including the Farasan Archipelago, must harbour many nesting and feeding habitats for turtles. The only documented information seems to be a specimen of Eretmochelys taken in Jeddah in the last century (Steindachner, 1900). There are reports of commercial exploitation, probably of Chelonia (Walczak, in lit., 1974).

Yemen Arab Republic. Despite a relatively short coastline, there are numerous offshore islands, and evidently rich areas of reef and marine pasture. Eretmochelys were collected on islands in the last century (Steindachner, 1900), and it and three other species have been reported in a recent survey: Dermochelys,

Chelonia and Lepidochelys. Chelonia is most common, but Eretmochelys are often encountered. Nesting occurs on coral islands, and possibly also on larger volcanic islands and the mainland. Probably both Chelonia and Eretmochelys nest, but neither has been confirmed. Human predation on eggs may be substantial in some areas (Walczak, 1975; 1979).

People's Democratic Republic of Southern Yemen. Three species are recorded from both the mainland and Socotra Island: Chelonia, Eretmochelys and Dermochelys. The latter is rare. Eretmochelys nest on Perim and Jabal Aziz Islands. Over a ten-day period on Jabal Aziz, 46 turtles laid eggs, and it seems that the annual nesting population is in the hundreds. Far fewer nest at Perim. The major pastures for Chelonia are in the west off Khor Umaria. Nesting occurs all along the mainland, but especially in Quaiti State. At Sharma, the major beach, there are evidently several thousand nesting annually, with a similar quantity at Ithmun beach. With year-round nesting there may be 10,000 Chelonia nesting in a year, mainly on these beaches in the east of the country. Females tagged on Sharma beach have turned up east of Aden and along the coast of Somalia from Hordio to Chismaio (Hinds, 1964-5; FAO, 1968, 1973; Hirth and Carr, 1970).

Arabian Sea, Gulf of Oman and Persian Gulf (see Ross and Barwani, 1982):

Oman. Masirah Island and Oman's mainland have been well studied since 1977. All five species are recorded from the Island, and all but Dermochelys nest. An estimated 30,000 Caretta and several hundred Chelonia nest annually on the Island. This is the largest known nesting population of Caretta. On the mainland, some thousands of Chelonia a year may nest, mainly at Ras Al Hadd. Perhaps 100 Eretmochelys and a similar number of Lepidochelys nest yearly on the island. Turtles are protected on nesting beaches and there is restricted fishing in nesting areas. The Government is committed to a management program (FAO, 1973; Anon., 1978; Ross, pers. comm., 1979).

United Arab Emirates. Little is documented.

Qatar. Chelonia mydas were said to have nested on the mainland, but not to nest now. Eretmochelys nest on islands, and Dermochelys has been reported. Caretta and Chelonia depressa have also been reported, but these records are not confirmed (Hunnam in Ross and Barwani, 1982).

Bahrain. Chelonia mydas may feed around the island (Gallagher, 1971).

Saudi Arabia. Chelonia mydas and Eretmochelys are reputed to nest on especially Karan Island, but also on Jana, Kurayn and Jurayd Islands, Dermochelys are uncommon (Basson, et al., 1977).

Kuwait. Chelonia mydas occur (Ross and Barwani, 1982).

Iraq. Dermochelys and Eretmochelys are listed (Khalaf, 1959; Mahdi and Georg, 1969).

Iran. The long, arid remote coast line has hardly been surveyed, but some islands in the Persian Gulf have been studied (Bullock and Kinunen, 1971; Kinunen and Walczak, 1970, 1971; Walczak and Kinunen, 1971). Four species are recorded: Dermochelys, Lepidochelys, Chelonia and Eretmochelys; the last two are common around islands, where there are marine pastures. There are fair numbers of turtles off the rocky eastern coast (Nehring, in lit., 25 Feb. 1975). A small fishery for Dermochelys on Larak Island may take 10 to 15 a year, and render them to oil for boat maintenance. Lepidochelys were seen at Lavan Island.

Turtles (Eretmochelys ?) nest on Larak and Lavan Islands in April and June (Bullock, Kinunen, Walczak, op. cit.); and Eretmochelys nests in April and June at Nakhilu (Anderson, in lit., 13 April 1977), Hormuz and Qeshm Islands, but the most nesting by this species is on Shitvar Island where there may be 100 a year. Nesting on the mainland is uncommon; it has been seen in October, in the east near the border with Pakistan, and in April inside the mouth of the Persian

Gulf. These may have been Chelonia, but there may be only a few hundred nesting annually (Bullock, Kinunen, Walczak, op. cit.).

Indian Subcontinent: (see Kar and Bhaskar, 1982):

Pakistan. The coast is highly variable, with cliffs over 100 m high in the west to the vast low-lying mangrove forests in the south at the mouth of the Indus. All five turtles are listed (Minton, 1962; Mohiuddin, 1975; Salm, 1975a, 1975b), but there is some question as to whether Eretmochelys or Caretta occur (Mertens, 1969). Dermochelys is rare (Minton, 1966; Mertens, 1969). Chelonia nests at Hawks Bay, evidently in the thousands, and also at Sandspit, Buleji and Paradise Point (Sind) and Ormara, Somniani and Ras Jiuiri (Baluchistan). Nesting is year-round with a peak from about August to October. Lepidochelys also nests at Hawks Bay and Sandspit during the same season, but in fewer numbers (Murray, 1884; Burton, 1918; Shockley, 1949; Hatt, 1957; Minton, 1966; Mertens, 1969; Minton and Minton, 1973; Mohiuddin, 1975; Salm, 1975a, 1975b, 1976a, 1976b). A large scale exporting business, dealing in turtle skins from Baluchistan, slaughters thousands of nesting animals; these have been reported to be Chelonia, but may in fact be Lepidochelys; details are not available (Salm, 1975a, 1975b, 1976a, 1976b; Telford, in lit., to H. Campbell, 1976).

India (See Kar and Bhaskar, 1982). The western and southern coasts, while providing thousands of km of sandy beach, are densely inhabited in general. All five species occur, possibly all nest. Nesting is evidently dispersed along most of the western coast but may be concentrated on uninhabited islands in the Gulf of Mannar.

The four chelonids are listed from the Gulf of Mannar (Gravelly, 1929; Kuriyan, 1950). Dermochelys reputedly nested in small numbers in southern Kerala at the end of the last century, and was occasionally caught in the earlier part of this century (Cameron, 1923). There may also have been sporadic nesting

farther north, eg., at Goa (Deraniyagala, 1939; Salm, 1976a). It is occasionally seen in the Gulf of Kutch (Bhaskar, 1978d, 1978e). Eretmochelys may occur, or nest, on islands in the Gulf of Kutch (Abdulali, 1963). It is reputed to nest also along the Gulf of Mannar, especially on offshore islands (Mudaliar, in Salm, 1975a). Chelonia occurs in numbers in the Gulf of Mannar where it grazes marine pastures, and there is a fishery (Sundara Raj, 1930) but nesting is rarely recorded. There is one published record from the Bombay area (Mawson, 1921), and evidently there was frequent nesting in this area in the 1930's (Abdulali, in lit., 6 Sept. 1976). They may still nest in small numbers from February to April (Salm, 1976a). They nest on islands in the Gulf of Kutch and may nest sporadically along the west coast (Bhaskar, 1978d, 1978e). Lepidochelys evidently nests along much of the coast; it is recorded from the Gulf of Kutch (Bhaskar, 1978d, 1978e), Bombay area (Greaves, 1935), near Goa (Salm, 1976a), as well as Krusadai Island in the Gulf of Mannar (Chacko, 1942; Luther, 1959). It evidently nests along much of peninsular India, both east and west (Whitaker, 1977), but nowhere in the concentrated numbers recorded in Orissa (cf. Bustard, in lit., 7 July 1976; Singh, in lit., 20 July 1976; Davis, 1977).

Turtles are common in the Lakshadweep (Laccadives) where four species nest: Chelonia, Eretmochelys, Lepidochelys commonly and Dermochelys rarely (Alcock, 1902; Hornell, 1908; Ayyangar, 1922; Deraniyagala, 1939; Bhaskar, 1978a, 1978b, 1978c, 1978f). The same species are also recorded from the Andamans and Nicobars (Bhaskar, 1979a, 1979c, 1979d) (The Andamans and east coast of India are in the eastern Indian Ocean and are mentioned here only to complete the national picture).

Maldives. This nation of hundreds of atolls and thousands of islands offers large areas of habitat to nesting and feeding turtles. Eretmochelys were said to be plentiful at the turn of the century (Boulenger, 1890; Laidlaw, 1902) and tortoise-shell has been an important export item for centuries. Chelonia is

also common and both these turtles nest, evidently in fair numbers. Dermochelys has been recorded but it is rare (Gardiner, 1906). Caretta was suspected to nest, but this was on the basis of egg sizes in a nest (Deraniyagala, 1956) and may be invalid. Lepidochelys seems to be common although it may not nest (Frazier and Didi, in prep.). Maldives are probably one of the most important areas for Eretmochelys in the region, and the population probably once numbered tens or hundreds of thousands. Chelonia were evidently less numerous and other species, uncommon. Heavy exploitation is probably reducing feeding and nesting populations considerably, but no figures are available.

Sri Lanka (see Bhaskar, 1982). Marine turtles were extensively studied by Deraniyagala (1939). All five species have been collected. Dermochelys nests especially from May to June and notably in the southeast, on the Yala coast; probably less than 100 nest annually. Lepidochelys is the most abundant species, evidently nesting throughout much of the year and around most of the island, although it is concentrated from September to January in the southwest. Several thousands may nest yearly. Chelonia, reported by Deraniyagala, nests infrequently and is recorded from July and November, from the south and from the northwest. However, Salm (1975a) reported year-round nesting. They are frequently caught in the Gulf of Mannar, and were once common all round the island (Kelaart, 1952), particularly Trincomalie Harbour. Caretta may nest around the Gulf of Mannar from June to August. In the 1930's, it was 1/20th as common as Lepidochelys. Eretmochelys may have two distinct nesting seasons: from November, or December to February and from April to June; these correspond to two general localities: the north and southwest, and the southeast (Deraniyagala, 1939). It was once "abundant," particularly in the south (Kelaart, 1852), or "plentiful" (Boulenger, 1890)--but no longer.

SUMMARY AND CONCLUSIONS

Distributions of nesting areas are shown in Figures 2, 3, 4, 5 and 6, and a tabular summary is given in Table 1. It must be emphasized that many of these estimates are preliminary and should be taken as indications only.

Dermochelys has the fewest rookeries and the smallest nesting population, with a total of less than 300 breeding in only four countries. Caretta also has very few rookeries, nesting in four or five countries, but the Masirah population, with some 30,000 nesting yearly, gives a total estimate of over 40,000 turtles nesting in a year. Lepidochelys may have many rookeries, involving at least eight countries; however, none of these appears to be large and the total number nesting may be little more than 4,000. Of course, the rookery in Orissa, eastern India, would swell this figure by hundreds of thousands. Eretmochelys has scores of nesting beaches and is known to nest in most countries. Yet none of these rookeries are large and the total number nesting annually in the entire region may be in the order of 4,000. Chelonia is by far the most common turtle in the western Indian Ocean, with rookeries in nearly every country, and 10 rookeries each with more than 1,000 nesting annually. The total number estimated to nest yearly in the region is nearly 40,000.

The status of the five different species in the western Indian Ocean is related to the sizes of their nesting populations. Dermochelys is in a precarious state, with less than 300 annual nesters and only two rookeries in reserves, i.e., Tongaland, Natal and Yala, Sri Lanka. This is ample reason to establish nesting reserves wherever Dermochelys nests regularly, i.e., southern Mozambique and perhaps also the Laccadives. In populated areas where nesting is irregular, eg., west and south coasts of India, the situation is more urgent, for these populations are smallest and under heavy pressure.

Caretta is numerically superior, and this is due especially to one rookery, Masirah. Yet, only two rookeries are in protected or managed areas: Tongaland and Masirah. The nesting turtles in Mozambique and Madagascar, while protected by law, are under heavy pressure. It is essential that the protected areas be maintained, for the future of the other populations is bleak.

Lepidochelys, with rookeries spread over the region, is generally more common than Caretta. However, the only major rookeries are likely to be in Pakistan and Sri Lanka, not including the east coast of India or other rookeries in the Bay of Bengal and eastern Indian Ocean. Nesting elsewhere is at a low level, and very few turtles seem to nest within protected areas, other than in Sind, Pakistan, and perhaps Sri Lanka. Protection for the major nesting populations in Baluchistan, Pakistan and Sri Lanka, as well as the smaller populations elsewhere, is needed--in the case of Baluchistan, it is needed urgently.

Eretmochelys rookeries are very common, although the turtles are not especially numerous. Some nesting is in protected areas (eg., in Tanzania and Kenya and on several islands in Seychelles), but most rookeries are not protected. The wide and abundant distribution of nesting areas gives the species insurance against local catastrophies, but the small numbers nesting under increasing demand from soaring prices of tortoise-shell (\$100/kg; see Frazier, 1980, 1982b) makes a gloomy future.

Chelonia has the most secure status in the western Indian Ocean region, with nesting in almost every country, several major rookeries, and tens of thousands estimated to nest yearly. However, it is imperative with this species, as with the others, to consider populations one by one, and not to think solely of the total estimate for the region. Historically, discrete nesting populations have been exploited by individual countries. The Seychellois, for example, can

take little consolation in the fact that there are major rookeries in Pakistan and Oman, for this makes little difference in the crop they can realize or the status of their stocks. Despite the large number of Chelonia over the region, many populations are in trouble, eg., Assumption Island, Seychelles; Mayotte; St. Brandon and Kenya. It is in the interest of the involved countries to establish effective nesting reserves to protect these populations.

A further problem is that, although nesting populations may be discrete, marine turtles do not respect national boundaries, but move over vast areas (Figure 7). Hence, several territories may be involved in the maintenance of one nesting population. If they do not cooperate in this venture, but one takes advantage of the situation, the turtle stocks may be reduced to an inviable level. International cooperation is one of the greatest problems in managing marine turtles.

However, with Chelonia and Eretmochelys, questions of extinction seem to be less relevant than questions of economics. These species are unlikely to be exterminated over their whole ranges, but populations reduced to low levels cease to be significant resources. Economic considerations of the minimum viable crop, transportation costs, etc., often result in inefficient exploitation and distribution (Frazier, 1979).

A further point which warrants careful consideration by countries with large turtle populations is the possibility of "losing" these large populations. Distinct nesting populations often seem to exploit the same food resources (Carr, 1975; Figure 7 herein). If country "A" reduces its turtle populations, this may result in other populations increasing and the establishment of a new lower equilibrium for country "A"'s turtle populations. This new low level may be quite independent of any attempts by "A" to rehabilitate its stocks. This phenomenon has been seen with population levels of different species of whales that feed on krill in the Southern Ocean (May, 1979).

Despite centuries of turtle hunting and recent increases in exploitation and habitat degradation, the status of marine turtles in the western Indian Ocean is not all bad. There are large populations of some species. The situation, however, must also be examined on a country-by-country basis, and in this light much of the picture is gloomy. There are many reasons for individual countries to make better attempts to manage their turtle resources, but a regional cooperative effort is also needed.

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ACKNOWLEDGEMENTS

The work was supported by: The Royal Society (London); Natural Research Council (U.K.); Fauna Preservation Society; East African Wildlife Society; African Wildlife Leadership Foundation; Department of Agriculture, Government of Seychelles; Government of BIOT; Game and Fisheries Departments of the Governments of Kenya and Tanzania; the Department of Zoological Research, National Zoological Park, and the Division of Reptiles and Amphibians, Smithsonian Institution; and a grant from the Smithsonian Scholarly Studies Program to Dr. J.F. Eisenberg. Many colleagues in many countries provided information. The expert assistance of Mrs. Wy Holden and Ms. Virginia Garber in typing and Ms. Sigrid James in illustrating was invaluable.

Table 1. Estimated number of turtles nesting annually for different species in different countries. ? indicates that the number given is an "educated guess." In fact, most of the numbers in this are preliminary estimates and should be treated as such. (Eastern India and the Andamans are not included).

Country	<u>Dermochelys</u>	<u>Chelonia</u>	<u>Eretmochelys</u>	<u>Caretta</u>	<u>Lepidochelys</u>
South Africa	70	0	0	400	0
Mozambique	50	300	100	300	?1,000
Madagascar	0	400	?300	300	?0
Reunion	0	5,200	50	0	0
Mauritius	0	300	25	0	0
BIOT	0	300	300	0	0
Seychelles	0	2,500	600	0	0
Mayotte	0	500	25	0	0
Comores	0	1,900	50	0	0
Tanzania	0	300	50	0	25
Kenya	0	200	50	0	25
Somalia	0	?2,000	?	0	0
Ethiopia	0	?100	?100	0	0
Sudan	0	?100	?500	0	0
Egypt	0	?50	?25	0	0
Sinai	0	100	0	0	0
Israel	0	0	0	0	0
Jordan	0	0	0	0	0
Saudi Arabia	0	?100	?500	0	0
Yemen A. Rep.	0	?100	?50	0	0
P. Dem. Rep. Yemen	0	?10,000	?300	0	0
Oman	0	7,000	100	30,000	150
UAE	0	?	?	?	?
Qatar	0	?	100	0	0
Bahrain	0	?	?	?	?
Saudi Arabia	0	500	100	0	0
Kuwait	0	?	?	?	?
Iran	0	200	200	0	?0
Pakistan	0	5,000	0	0	1,000
India	25	200	150	0	500
Madives	0	?2,000	500	0	?
Sri Lanka	100	100	50	?	2,000
<hr/>					
TOTAL	245	39,450	4,225	40,000	4,700

Figure 1. The Indian Ocean. Mainland Countries:

A = Israel, B = Jordan, C = Iraq, D = Egypt,
E = Sudan, F = Ethiopia, G = Djibouti, H = Somalia,
I = Kenya, J = Tanzania, K = Mozambique,
L = South Africa, M = Saudi Arabia, N = Iran,
O = Kuwait, P = Pakistan, Q = India, R = Bangladesh,
S = Burma, T = Thailand, V = Malaya, W = Indonesia,
X = Madagascar, Y = Yemen Arab Republic, Z = People's
Democratic Republic of Yemen, A-1 = Oman.

Islands: 1 = Masirah (Oman), 2 = Socotra (PDRY),
3 = Laccadives (India), 4 = Maldives, 5 = Seychelles,
6 = Aldabra (Seychelles), 7 = Mayotte (France),
8 = Comores, 9 = Tromelin (Reunion, France),
10 = St. Brandon (Mauritius), 11 = Rodriguez
(Mauritius), 12 = Mauritius, 13 = Reunion (France),
14 = Europa (Reunion, France), 15 = Andamans,
16 = Nicobars, 17 = BIOT (Chagos).

Figure 2. Nesting areas of Dermochelys coriacea in the western Indian Ocean.

Symbols:

- ? = Questionable record, or suspected to occur
- X = Occurs
- * = Occurs in large numbers
- = Suspected to nest
- = Less than 100 nest annually
- ▲ = 100 to 1,000 estimated to nest annually
- = 1,000 to 10,000 estimated to nest annually
- ★ = Over 10,000 estimated to nest annually

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Figure 3. Nesting areas of Caretta caretta in the western Indian Ocean (symbols as in Figure 2).

Figure 4. Nesting areas of Lepidochelys olivacea in the western Indian Ocean (symbols as in Figure 2).

Figure 5. Nesting areas of Eretmochelys imbricata in the western Indian Ocean (symbols as in Figure 2).

Figure 6. Nesting areas of Chelonia mydas in the western Indian Ocean (symbols as in Figure 2).

Figure 7. Post-nesting movements (feeding migrations) of marine turtles in the western Indian Ocean:

A) Chelonia mydas nesting in: P. D. R. Yemen (data from Hirth and Carr, 1970; FAO, 1973); Tromelin Island and Europa Island (data from Hughes, 1974b, 1977b) and Ras Al Hadd, Oman (data from Ross and Barwani, this volume); and Dermochelys coriacea nesting in Natal (dashed line) (data from Hughes, 1974b).

B) Caretta caretta nesting in Natal (data from Hughes, 1974b, 1975b, 1977a, 1977b, this volume).

Short arrows show possible dispersions from other major nesting areas of these species.

Arrows show only locations of tagging and releasing and locations of recapture--not routes taken by dispersing turtles.













